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A MEASUREMENT OF THE NEUTRON-PROTON DEPOLARIZATION PARAMETER AT 23 MEV

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The neutron-proton depolarization parameter was determined by comparing the scattered neutron polarization to the neutron polarization before scattering. Neutrons of 23.1 MeV and approximately 50 percent polarization were produced in the T(d,n) reaction and were scattered from protons contained in a plastic scintillator. The scattered neutron polarization was analyzed by scattering in a liquid helium scintillator. A triple coincidence between the recoil proton, the recoil alpha particle, and a final neutron detector served to identify the events and to reduce backgrounds to a low level. The values of the depolarization parameter for center-of-mass scattering angles of 70, 90, and 110 degrees were measured to be $+0.56 \pm 0.20$, $+0.81 \pm 0.17$, and $+0.81 \pm 0.20$, respectively.

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Various parameters in the neutron-proton system at 23 MeV are being measured in Los Alamos in an effort to test the validity of several theoretical predictions. A measurement of the differential cross section [1] is presently being refined. The polarization has been measured [2] and preparations are being made to measure the spin correlation parameter C_{nn} by means of scattering polarized neutrons from a polarized proton target. The depolarization measurement is one of a series of experiments in which the change in the polarization of neutrons scattered by unpolarized protons is measured. The depolarization parameter D is measured in a geometry where the incident neutron polarization vector P_1 is made normal to the n-p scattering plane, and the normal component of the scattered neutron polarization is observed. Under these conditions, D is related to the observables by the equation:

$$D = \frac{1}{P_1} \left[\frac{e}{P_3} (1 + P_1 P_2) - P_2 \right]$$

where e is the measured asymmetry in the final scattering, P_3 is the analyzing power in the final scattering, P_2 is the n-p polarization, and P_1 is the source polarization.

Fig. 1 shows a plan view of the experimental setup. The $T(d,n)$ reaction at a deuteron energy of 7.0 MeV produced 23.1 MeV neutrons at $\theta_1 = 30^\circ$ lab. of approx. 50 percent polarization. [3,4]

*Work done under the auspices of the U. S. Atomic Energy Commission.

These were scattered at an angle θ_2 by protons in the plastic scintillator (S1). The normal component of the scattered neutron polarization was analyzed by scattering in a liquid helium scintillator [5] (S2) into a final neutron detector (S3). A spin-precession solenoid rotated the neutron spin vector by $\pm 90^\circ$ to permit asymmetry measurements to be taken without the necessity of moving S3.

The double scattering events were identified by means of a fast triple coincidence between signals generated in the three detectors. A parallel slow system allowed suitable pulse height bounds to be placed on each signal. Additional circuitry permitted simultaneous measurement of the dominant chance coincidence rates, which were subtracted from the in-phase rates before calculating the asymmetry ϵ .

The $T(d,n)$ source polarization under the conditions of this experiment was taken to be $P_1 = 0.48 \pm 0.06$. This value was obtained by averaging the angular dependence of P_1 over the angular range subtended by S1 and using a recent measurement of the $T(d,n)$ polarization.

[4] The value of P_2 was taken from our earlier measurements. [2] The neutron-helium analyzing power P_3 was calculated from the Dodder-Gammel-Seagrave phase shifts, [6] to which corrections for angular resolution and neutron multiple scattering were made. The values of D for c.m. scattering angles of 70° , 90° , and 110° were measured to be $+0.56 \pm 0.20$, $+0.81 \pm 0.17$, and $+0.81 \pm 0.20$, respectively. The listed errors are standard deviations which are dominated by the statistical uncertainties in the asymmetry measurements but also include the uncertainties in the values of P_1 and P_2 . These values are plotted

in Fig. 2 along with two representative theoretical predictions. The curve labeled Breit is an interpolation to 23.1 MeV of an energy dependent set of phase shifts adjusted to best fit existing n-p and p-p data from 10 to 50 MeV. [7] The curve labeled Hamada and Johnston is based upon a linear interpolation to 23.1 MeV of phase shifts calculated from the Hamada and Johnston potential. [8] The datum point at 70° c.m. falls lower than the curves by 1.6 standard deviations. We do not consider the deviation significant, and to the accuracy of this experiment, we consider the data to be consistent with the theoretical predictions.

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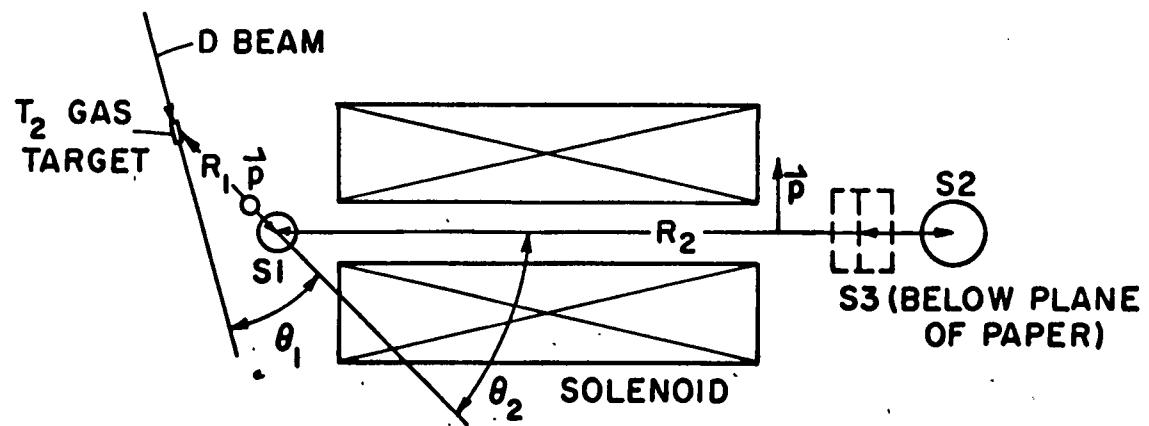
Figure Captions:

Fig. 1: Plan and elevation view of the depolarization experiment.

Fig. 2: The depolarization measurements along with two theoretical predictions at 23.1 MeV as a function of the n-p scattering angle.

FIGURE 1

PLAN VIEW



ELEVATION VIEW

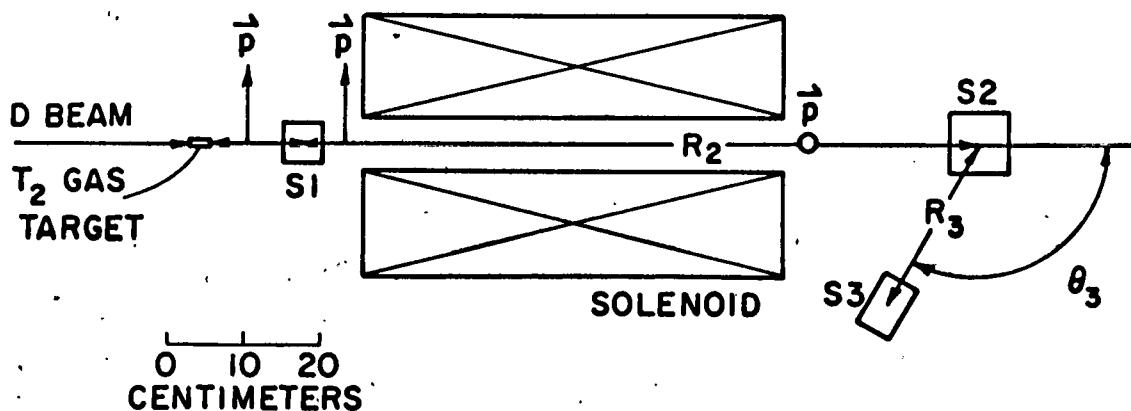


FIGURE 2

